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RISKS TO INFANTS ON GUAM FROM BITES OF THE BROWN TREE SNAKE (*BOIGA IRREGULARIS*)

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Abstract. The brown tree snake, ***Boiga irregularis,*** is abundant on Guam and commonly invades human habitations. Data on emergency room visits on Guam document a high freguency of snakebites on Guam. Over 50% of the emergency room visits for snakebite involved children <4 years old. Records exist of **4** infants, **1, 2,** 5, and **10** months old, who displayed significant symptoms after being bitten, while sleeping, by snakes. Two infants developed respiratory problems within a few hours and required medical treatment for asphyxiation. Lethargy, diminished sensory perceptions, drooping eyelids, swelling, discoloration, and bleb formation were variable in occurrence in the patients.

The brown tree snake, ***Boiga irregularis,*** is an introduced species on Guam and occurs in dense populations in close proximity to humans. This causes serious problems due to the effects the snakes have on the electrical system, native vertebrate fauna, and the overall ecology of the island.[1–4] Snakes frequently invade houses, and snakebites are common in Guam.[3] Little is known about the potential medical risk to humans; most residents of Guam and most authors familiar with the snake in its native range assume the snake to be harmless or, at the worst, capable of delivering only a painful bite. The snake strikes readily when threatened.[5] The bite of the brown tree snake in Papua New Guinea has been described as comparable to a bee sting, with the venom reportedly causing local swelling and itching.[6] The species is described by Cogger as not dangerous to humans,' but this assessment should be viewed as relative to several extremely dangerous snakes of the family Elapidae that occur with the brown tree snake in Australia and the Papua New Guinea area.

The snake is known to be mildly venomous with enlarged Duvernoy's glands and grooved fangs. The **2** posteriormost teeth on each maxilla are enlarged and curved posteriorly with grooves on the anterior surfaces.

Envenomation was reported for a bite of the mangrove snake, ***B. dendrophila.***[8] Swelling and prolonged discoloration of the skin in the area surrounding the bite were observed by adults bitten by large brown tree snakes at the Philadelphia Zoological Garden (John D. Groves, Philadelphia Zoological Garden, Philadelphia, PA, personal communication). A significant neurotoxic component capable of inhibiting the neural functions at neuromuscular junctions was described in the venom of Blanding's tree snake, ***B. blandingi,*** but has not been identified in Asian species of the genus.[9] The venom of ***B. blandingi*** causes rapid death in small animals. We present data on persons visiting the emergency room of the Guam Memorial Hospital for treatment of snakebite and on the symptoms observed in **4** of these patients.

MATERIALS AND METHODS

Only 2 snakes occur on Guam, the brown tree snake and a diminutive blind snake (***Ramphotyphlops braminus).*** The latter species is precluded from biting humans by its small size. Sea snakes do not occur near Guam. Thus, we have assumed that all snakebite victims on Guam were bitten by the brown tree snake.

The data on emergency room visits for treatment of snakebite were extracted from the records of the emergency room at Guam Memorial Hospital as a part of a program monitoring various infectious diseases and injuries caused by animals. Data span **21** September **1986** through 30 July **1989,** a period of **1,042** days. Data were unavailable for **–2** weeks in December **1987.** The data include the total number of emergency room visits arranged chronologically and the number of cases attributed to bites by snakes, dogs, cats, rats, and moray eels, as well as injuries caused by other animals. In most cases the age and sex of the patient were recorded. Symptoms attributed to the venom of the brown tree snake are described for **4** infants from medical records

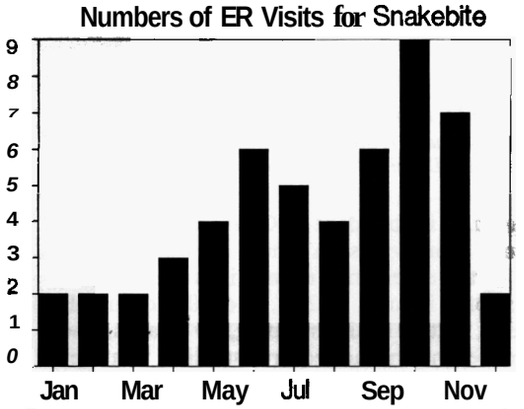

FIGURE 1. Seasonal variation in the number of snakebite victims visiting the Guam Memorial Hospital emergency room. Data summarized by month for September 1986–July 1989.

and interviews of attending medical personnel and parents of the children.

RESULTS

The records document 65,786 persons visiting the emergency room for treatment. Fifty-three sought treatment for snakebite, ~ 1 in 1,200 patients.

Age and sex data exist for 37 individuals, 16 males and 21 females. Nineteen were <4 years old. Ten bites involved infants <6 months old and 2 infants were 1 and 2 weeks old.

The number of bites recorded for June–November (37) is more than double the number for December–May (16) (Fig. 1). Correcting for the unequal reporting for the months of August and September (i.e., records extend from September 1986 through July 1989) and the missing data for the short period in 1987 did not markedly change the seasonality evident in reported snakebites. The largest number of reported snakebites occurred in September, October, and November, coinciding with the end of the rainy season.[2]

Case 1

A 2-month-old male (weight unknown) arrived at the emergency room of the Guam Memorial Hospital at 0650 hours on 6 August 1987 suffering respiratory difficulties. The infant was treated with norepinephrine by the attending physician and placed in the intensive care unit for further observations. Earlier (~0210 hours) the child had been discovered in his bed at home in Inarajan, Guam with a brown tree snake chewing on his arm and wrapped around his neck and left arm.[3] The snake (THF 7295) weighed 165 g and had a total length of 1,488 mm. Our information on the symptoms experienced by the child is based on an oral report by the emergency room personnel who attended the child. The boy responded to the treatment and recovered sufficiently to be released from the hospital 2 days later.

Case 2

A 5-month-old female (6.6 kg), bitten on the hand while in her crib on 3 March 1989 at her home in the village of Yigo, Guam, arrived at the U.S. Naval Hospital on 3 March 1989. On amval the child exhibited normal behavior with a pulse rate of 140 and a respiratory rate of 43, but ~2 hr postbite, her respiratory rate increased. The heart rate increased to 240, and shortly thereafter she had respiratory arrest with a pulse rate of 70. The infant was intubated and ventilated with oxygen and her pulse returned to 240. There were copious upper and lower airway secretions which were removed by suction. Neurological examination revealed disorientation, spastic movements of the extremities, lack of response to vocalizations, and sluggish pupil response to bright light. Swelling extended from the hand to the mid forearm. Three days postbite, there were numerous blebs over the fingers and dorsum of the hand (Fig. 2).

Local signs resolved without evidence of necrosis or infection. The respiratory arrest and marked cardiac oscillations were judged to be critically serious with a guarded prognosis. The child spent 4 nights at the hospital and was discharged on 8 March 1989. The attending physician recorded the episode as respiratory failure with near cardiac arrest, possibly anaphylactoid reaction.

On the day of the bite, the girl's mother had noticed several tooth marks on the dorsal and ventral surfaces of the wrist and on the palm of the child's hand after responding to the child's cries at 2100 hours. The hand was noticeably swollen. Search of the room revealed a snake, reported to be 5 feet long, entering a crib where the girl's twin brother was sleeping. The snake was killed and taken along with the injured infant to the Naval Hospital on Guam. The child had

FIGURE 2. The right hand of a 5-month-old infant (Case 2) with marked swelling, discoloration, and bleb formation on the third day after a bite by a brown tree snake.

been put to bed at 1800 hours in apparent good health.

Case 3

A 10-month-old boy (10 kg) from Ypan, Guam arrived at Guam Memorial Hospital on 12 August 1989, −2 hr after suffering a snakebite. The left hand was swollen and by 3 hr postbite the swelling had extended up the lower arm; at 6 hr postbite the swelling had reached the elbow. The skin had become tense but not discolored. Approximately 4 hr postbite, the baby was noted to be cranky, with drooping eyelids, and an inability to stand upright or walk. By 1300 hours (7 hr postbite), the child was awake but limp. The child was admitted to the intensive care unit at −7 hr postbite. The parents noted improvement in the child's disposition and attentiveness at 0200 on 13 August 1989, nearly 20 hr after the bite. He was released from the hospital the following day.

On the day of the bite the boy had awakened his parents at 0600 hours and was standing in his crib grasping a snake at midbody with the tail wrapped around the child's neck and the anterior body wrapped around his leg. The snake was an adult male weighing 168 g and was 1,305 mm in length (MJM 1218).

The left hand of the child had tooth marks on the dorsal and palmer surfaces of the hand and on the fourth and fifth fingers. The presence of saliva on the hand and the large number of tooth marks suggest that the snake had attempted to swallow the hand. At the time of discovery, the hand was swollen in the region of the bite. The child lost use of the hand when the hand and arm became markedly swollen. The arm remained swollen until 15 August 1989.

Case 4

A 4-week-old male infant (5.4 kg) experienced bleeding, localized swelling, and bruising on one hand after being bitten by a brown tree snake on 20 September 1989 in Talofofo, Guam. No medical attention was sought. By the next morning, −8 hr postbite, the child was lethargic and had droopy eyelids. Within a few days, no symptoms were evident. The parents had been awakened by the cries of the infant sleeping between them and, upon noting the bite on the child's hand, searched for and found a snake (~ 1,370 mm long) in the room.

DISCUSSION

Many people on Guam believe the brown tree snake is harmless and therefore do not usually seek medical attention for bites. Apparently many bites cause only minor symptoms, if any. Thus the number of people bitten is probably higher than documented by the data presented here. Guam Memorial Hospital is the largest medical facility on the island, but there are other facilities that may receive patients seeking treatment for snakebite.

Bites on children warrant careful interpretation. Parents may be more likely to seek medical help when a child is bitten than when an adult experiences a similar bite. However, the large number of bites involving infants relative to older children and adults suggests a tendency for the snake to enter houses and attack sleeping children. Snakebite cases involving other snakes are most frequently attributable to carelessness, ignorance of danger, and bravado, but none of these factors would explain bites on sleeping infants.[10] Elsewhere, only kraits (*Bungaris*) have a reputation for biting sleeping victims, but this behavior has not been adequately explained.[10] The severity of the bite (i.e., the likelihood of envenomation

omation) is increased for small children by the child's small body size, the inability to escape or avoid the snake if it chooses to envenomate by chewing, and the inability to communicate the distress to adults or older children nearby. A bite suffered by an adult or active child handling the snake is likely to be a quick strike followed by the snake releasing, whereas the intentional bite associated with feeding involves holding on and definite masticatory movements facilitating injection of the venom into the prey. If such bites are occurring in the infants being bitten by the brown tree snake in Guam, the probability of serious envenomation is increased inversely proportional to the size and activity of the child. In several cases, in addition to those described above, parents have found snakes coiled around the neck and body, and chewing on the limbs and heads of children. The brown tree snake responds to both visual and olfactory cues during feeding, and snakes frequently attack prey much too large to be successfully engulfed.[4,11,12] Residents of Guam have reported attacks on newborn pigs, puppies, and other animals too large to be swallowed. For example, in October 1986, a snake weighing 69 g that was 112 cm long attacked and killed a labrador puppy (*Canis familiaris*) weighing 600 g and measuring 25 cm from crown to rump. Whether such attempts are stimulated by extreme hunger or by undetermined olfactory cues stimulating a feeding response is unknown. Other examples exist of snakes biting sleeping adults on the hands, faces, and eyelids, but it is difficult to determine whether such bites are in response to movements, potential threats, or feeding stimuli. The symptoms reported here are likely to have resulted from the snakes deliberately chewing on the sleeping children, thereby facilitating venom injection.

Two of the 4 infants exhibited respiratory problems requiring emergency treatment. Three of the infants are known to have had marked swelling with varying degrees of skin discoloration and bleb formation. The oldest child exhibited swelling without discoloration and blebs.

Although the recovery of all four infants has been complete, the respiratory problems and associated symptoms experienced could have been fatal if not treated by capable medical personnel. Attention should be given to early detection of respiratory and neurological signs and symptoms by careful monitoring of patients with bites by the brown tree snake.

No fatalities are known to have been caused by this species, but the high numbers of snakes in close proximity to human residential areas on Guam contribute to the possibility of snakes biting infants. There obviously is a need for increased precautions to exclude snakes from rooms where small children sleep and for better dissemination of information to the medical community and the general public on Guam and in the native range of the species. Better documentation of the signs and symptoms of bites by this species is currently being sought by the Public Health Division in Guam and toxicological studies are in progress in the laboratories of Kenneth Kardong and Darwin Vest at Washington State University, Pullman, Washington.

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REFERENCES

1. Savidge JA, 1987. Extinction of an island forest avifauna by an introduced snake. Ecology 68: 660–668.
2. Fritts TH, Scott NJ Jr, Savidge JA, 1987. Activity of the arboreal brown tree snake (Boiga irregularis) on Guam as determined by electrical outages. *The Snake 19:* 51–58.
3. Fritts, TH, 1988. The brown tree snake, Boiga irregularis, a threat to Pacific Islands. *US Dept of Interior, Fish Wildl Sv Biol Rep 88:* 1–36.
4. Fritts TH, Scott NJ Jr, Smith BE, 1989. Trapping

Boiga irregularis on Guam using bird odors. *J Herpetol 23:* 189–192.
5. Johnson CR, 1975. Defensive display behaviour in some Australian and Papuan-New Guinean pygopodid lizards, boid, colubrid, and elapid snakes. Zool J *Linn Soc 56:* 265--282.
6. Parker F, 1983. The snakes of the western province. *Wildl Papua New Guinea 82:* 32–33.
7. Cogger HG, 1975. *Reptiles and amphibians of Australia.* Sydney: A. H. and A. W. Reed.
8. Burger WL, 1974. A case of mild envenomation by the mangrove snake, Boiga dendrophila. *The Snake* 6: 99–100.
9. Levinson SR, Evans MH, Groves F, 1976. A neurotoxic component of the venom from Blanding's tree snake (Boiga blandingi). *Toxicon 14:* 307–312.
10. Minton SA Jr, Minton MR, 1980. *Venomous reptiles.* New York Charles Schribner and Sons.
11. Chiszar D, Kandler K, Lee R, Smith HM, 1988. Stimulus control of predatory attack in the brown tree snake (Boiga irregularis). 2. Use of chemical cues during foraging. *Amphibia-Reptilia 9:* 77–88.
12. Chiszar D, Kandler K, Smith HM, 1990. Stimulus control of predatory attack in the brown tree snake (Boiga irregularis). 1. Effects of visual cues arising from prey. *The Snake:* (in press).